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SPECIFICATION

TITLE

# METHOD FOR SWITCHING DATA RECEIVED VIA A PACKET-ORIENTED DATA TRANSMISSION PATH

## BACKGROUND OF THE INVENTION

Field of the Invention

1 The invention is directed to a method for switching data that are received via a packet-oriented data transmission link and are to be forwarded.

Description of the Related Art

2 The significance of transmission and switching techniques for high data transmission rates (above 100 Mbit/s) is increasing due to the increasing need for a transmission of video information in modern communications technology. Such video information may include still and moving images in picture telephony applications or the presentation of high-resolution graphics at modern data processing systems.

3 A known data transmission method for high transmission bit rates is the "asynchronous transfer mode" (ATM). A data transmission on the basis of the asynchronous transfer mode currently enables a variable transmission bit rate of up to 622 Mbit/s. In this transfer mode, data packets having a fixed length ("ATM cells") are used for the data transport. An ATM cell is composed of a cell header that is five bytes long and contains the switching data relevant for the transport of an ATM cell and of a 48 byte long payload field. Only data allocated to one logical connection – frequently referred to as a virtual channel VC or ATM channel – are transmitted in the payload field of an ATM cell.

4 US patent no. 5,784,371 discloses a communication network formed of a plurality of communication systems that are connected to one another via an ATM network. The communication systems respectively comprise a timeslot-oriented switching network module for a connection of timeslot-oriented terminal devices to the respective communication system, by which a bidirectional switching of data to

be exchanged between the device and the packet-oriented ATM network ensues with the timeslot-oriented switching network modules.

5 The German Patent Application serial number 198 187 76.9 discloses a method that enables a transmission of data belonging to different logical connections in the payload region of one or several ATM cells. To this end, "sub-structure elements" having a variable payload field 0 through 64 bytes long is defined in the payload field of an ATM cell, these sub-structure elements being capable of being respectively allocated to a logical connection via an address field in the cell header of the sub-structure element. Due to the 8-bit long address field in the cell header of a sub-structure element, a maximum of $2^8 = 256$ different logical connections can be addressed. Additionally, at least one sub-structure element is reserved for a transmission of signaling information allocated to the logical connections.

6 The article by Mauger, R., et al., "ATM Adaptation Layer Switching" ISS, World Telecommunications Congress (International Switching Symposium), Ca, Toronto, Pinnacle group, pages 207-214, XP000720525, discloses an arrangement for a switching of data received via a timeslot-oriented data transmission link and a packet-oriented data transmission link. This arrangement comprises both a timeslot-oriented switching network module as well as a packet-oriented switching network module. A switching of data received via the packet-oriented data transmission link and to be forwarded via a packet-oriented data transmission link as well takes place with the packet-oriented switching network module.

## SUMMARY OF THE INVENTION

7 An object of the present invention is to specify an alternative method that enables a switching of data that are received via a packet-oriented data transmission link and are to be forwarded.

8 This object is achieved by a method for switching data that are received via a packet-oriented data transmission link and are to be forwarded, in which data packets subdivided into sub-structure elements are established for a data transmission via the packet-oriented data transmission link, comprising the steps of

allocating, by a conversion unit, an allocation of the data received via the packet-oriented data transmission link to channels of a timeslot-oriented data format formed of a periodic sequence of channel-individual information segments, such that data allocated to a sub-structure element are allocated to at least one channel of the timeslot-oriented data format; switching the data converted into the timeslot-oriented data format via a timeslot-oriented switching network module; converting the timeslot-oriented data back into the packet-oriented data format; and transmitting the data coverted back into the packet-oriented data format via the packet-oriented data transmission link.

9 A critical advantage of the inventive method is that a switching of data allocated to different logical connections and transmitted in one or several data cells can ensue via a traditional timeslot-oriented switching network module. A development of a switching network module designed for the present packet-oriented data format and a signaling adapted to it are thus not necessary.

10 Advantageous developments of the invention include providing that the step of transmitting data via the packet-oriented data transmission link ensues according to the asynchronous transfer mode data format. The inventive method may also include reserving a sub-structure element for a transmission of signaling information allocated to data transmitted via the packeted-oriented data transmission link. Further steps may be added including receiving signaling information by the conversion unit; communicating the received signaling information from the conversion unit to a control unit; and coverting the signaling information into switching-oriented control data for the timeslot-oriented switching network module. Filter cells may be inserted for an adaptation of a transmission bit rate deriving due to an arrival and size of sub-structure elements to a transmission bit rate of a channel. A further step may include inserting filler data into a sub-structure element for an adaptation of a transmission bit rate deriving due to an arrival and a size of sub-structure elements to a transmission bit rate of a channel. Finally the inventive method may include transmitting, for each channel, information about a plurality of payload data communicated in a channel and information about a plurality of filler data communicated in the channel.

11 One advantage of developments of the invention is that, among other things, the insertion of filler cells or of filler data into a sub-structure element during the conversion of a packet-oriented data format into a timeslot-oriented data format makes a switching of compressed data possible without a preceding decompression, which avoids a quality loss in the switching of compressed data.

## BRIEF DESCRIPTION OF THE DRAWINGS

12 An exemplary embodiment of the invention is explained in greater detail below on the basis of the drawings.

Figure 1 is a block diagram of the schematic illustration of the critical function units participating in the inventive method;

Figure 2 is a data structure diagram of the schematic illustration of the conversion of a packet-oriented data format into a timeslot-oriented data format according to a first operating mode of a conversion unit; and

Figure 3 is a data structure diagram of the schematic illustration of the conversion of the packet-oriented data format into the timeslot-oriented data format according to a second operating mode of the conversion unit.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

13 Figure 1 shows a schematic illustration of a communication system PBX. The communication system PBX comprises subscriber or network line/trunk modules -- a line/trunk module ABG is shown by way of example -- for the connection of communication terminal devices or for a connection to a communication network -- for example, an ISDN-oriented communication network, an analog communication network, a radio communication network or an ATM-based communication network.

14 Furthermore, the communication system PBX contains a timeslot-oriented switching network module KN comprising a plurality of bidirectional, time-division multiplex-oriented switching terminals KA, where the time-division multiplex-oriented switching terminals KA are fashioned as PCM terminals (pulse code modulation), also referred to as PCM highways, speech highways or $S_{2M}$ terminals. Given an internal data transmission of the communication system, a PCM highway generally

comprises 32 payload channels that are fashioned as ISDN (integrated services digital network)-oriented B-channels with a respective transmission bit rate of 64 kbit/s.

15 A line unit AE and a conversion unit UE are arranged on the line/trunk module ABG. The communication system PBX is connected to an ATM-based communication network ATM-KN via a network interface NA of the line unit AE, the ATM-based communication network ATM-KN being composed of a plurality of communication systems connected to one another. A first and a second communication terminal device KE-A, KE-B are connected to the ATM-based communication network ATM_KN. The line unit AE is connected to a bidirectional, packet-oriented terminal SK of the conversion unit UE via a its own bidirectional, packet-oriented terminal SK.

16 The conversion unit UE is also connected to a switching terminal KA of the timeslot-oriented switching network module KN via its own bidirectional, time-division multiplex-oriented switching terminal KA. The timeslot-oriented switching network module KN is respectively connected, via further switching terminals KA (not shown), to a bidirectional time-division multiplex-oriented terminal SK of further subscribers or line/trunk modules (not shown) arranged in the communication system PBX.

17 A bidirectional conversion between the packet-oriented data format of a connecting line PO-VL between the conversion unit UE and the line unit AE and the timeslot-oriented data format of a connecting line ZO-VL between the conversion unit UE and the timeslot-oriented switching network module KN ensues with the conversion unit UE according to two different operating modes of the conversion unit UE that are described in greater detail below.

18 Furthermore, a control unit STE comprising a plurality of control terminals S1, S2 is arranged in the communication system PBX. The control unit STE is connected to a control input SE of the timeslot-oriented switching network module KN via a control terminal S2, and is connected to a control input SE of the line/trunk module ABG via a control terminal S1. The control unit STE is connected to control inputs of further subscribers or line/trunk modules arranged in the communication system PBX via further control terminals (not shown). A communication of signaling

 

information between the control unit STE and the timeslot-oriented switching network module KN or the line/trunk module ABG ensues according to the HDLC data format (high level data link control).

19 Figure 2 shows a schematic illustration of a conversion of the packet-oriented ATM data format according to the ATM adaption layer AAL type 2 into the timeslot-oriented data format according to the TDM method (time-division multiplex) in a first operating mode of the conversion unit UE. A data transmission in the framework of the packet-oriented ATM data format ensues via ATM cells ATM-Z1, ATM-Z2. An ATM cell ATM-Z1, ATM-Z2 is composed of a five byte long cell header H containing the switching data relevant for the transport of an ATM cell ATM-Z1, ATM-Z2 and of a 48 byte long payload field.

20 In a data transmission in the framework of the packet-oriented ATM data format according to the ATM adaption layer AAL type 2, there is the possibility of subdividing the payload area of an ATM cell ATM-Z1, ATM-Z2 into sub-structure elements SE. The adaptation of the ATM data format -- also frequently referred to as "ATM layer" (layer 2) in the literature -- to the switching layer (layer 3) according to the OSI (open systems interconnection) reference model takes place with the "ATM adaption layer" AAL.

21 A sub-structure element SE according to the ATM adaption layer AAL type 2 is composed of a 3 byte long cell header and of a variable-length payload area I (0 through 64 bytes). The cell header of a sub-structure element SE is subdivided into an 8 bit long channel identifier CID, a 6 bit long length indicator LI, a 5 bit long transmitter-receiver indication UUI (user-to-user indication) and a 5 bit long cell header checksum HEC (header error control).

22 As a result of the subdivision of an ATM connection with the assistance of sub-structure elements SE into mutually independent data streams, as shown in Figure 2 with reference to the example of the ATM cells ATM-Z1, ATM-Z2, up to $2^8$ = 256 different logical connections can be addressed within an ATM connection of the basis of the 8 bit long channel identifier CID, all of these logical connections being addressed with the same ATM address -- composed of a VPI (virtual path identifier) value and of a VCI (virtual channel identifier) value. In addition, there is the

possibility of defining a sub-structure element SE for a transmission of signaling information allocated to the logical connections. For a transmission of payload data allocated to the logical connections, one sub-structure element SE can be defined for every currently required logical connection, so that the transmission capacity can be exactly matched to the current need.

23 For example, four different sub-structure elements SE are shown in Figure 2 that are defined on the basis of different channel identifier CID in the cell header -- referred to below as the sub-structure element header 0, 1, 2, 3 -- of the sub-structure elements SE. A payload field I of variable length (0 through $2^6$ bytes) can be defined by the 6 bit long length indicator LI in the cell header, so that a data transmission with a variable transmission bit rate can be realized for the different logical connections.

24 For a conversion of the packet-oriented data format according to the ATM adaption layer AAL type 2 onto the timeslot-oriented data format according to the TDM method, a TDM channel K0 through K3 of the timeslot-oriented data format according to the TDM method is allocated to each element SE of an ATM cell ATM-Z1, ATM-Z2 defined for a transmission of payload data. An allocation of a sub-structure element SE to a TDM channel K0 through K3 ensues in a signaling phase preceding the payload transmission. 32 payload channels, which are configured as ISDN-oriented B-channels with a constant transmission bit rate of respectively 64 kbit/s, are generally available for a data transmission in the framework of the timeslot-oriented data format according to the TDM method.

25 In the framework of the conversion of the packet-oriented data format according to the ATM adaption layer AAL type 2 onto the timeslot-oriented data format according to the TDM method, an adaptation of the (potentially variable) transmission bit rate of the packet-oriented data format deriving due to the size and the arrival of sub-structure elements SE onto the constant transmission bit rate of 64 kbit/s of the timeslot-oriented data format must additionally ensue. This is achieved in the scope of the first operating mode of the conversion unit UE by an insertion of "filler cells" FZ of variable length into the continuous TDM data stream.

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26 The sub-structure element SE received via the packet-oriented connecting line PO-VL and packed in ATM cells ATM-Z1, ATM-Z2 must be unpacked in the conversion unit UE. For the conversion of the (potentially variable) transmission bit rate deriving due to the size and the arrival of the sub-structure elements SE onto the constant transmission bit rate of 64 kbit/s of the timeslot-oriented data format, filler cells FZ are subsequently attached to the sub-structure elements SE containing the payload data. The length of a filler cell FZ is defined by a filler cell header FZH. The length of a filler cell FZ is selected such that the overall transmission bit rate of a sub-structure element SE and of a filler cell FZ yields a whole multiple of 64 kbit/s. When the transmission bit rate of a sub-structure element SE is higher than 64 kbit/s -- i.e., higher than the transmission bit rate of a TDM channel K1 through K4 -- the payload data communicated in a sub-structure element SE are divided onto a plurality of TDM channels K1 through K4.

27 In conclusion, these data (sub-structure elements SE and filler cells FZ together) are allocated to a TDM channel K0, K1 of the timeslot-oriented connecting line ZO-VL declared in the signaling phase and are transmitted via this to the timeslot-oriented switching network module KN.

28 The signaling information communicated from the conversion unit UE to the control unit STE of the communication system PBX in the framework of the signaling phase are converted in the control unit STE into switching-oriented control data for the timeslot-oriented switching network module KN. A switching of the data (sub-structure elements SE and filler cells FZ together) received via the respective TDM channels K0 through K3 of the timeslot-oriented connecting line ZO-VL ensues in the timeslot-oriented switching network module KN on the basis of the switching-oriented control data, i.e., an allocation of a TDM channel of an input line of the timeslot-oriented switching network module KN onto a TDM channel of an output line of the timeslot-oriented switching network module KN.

29 When the payload data to be communicated are to be transmitted anew via the ATM-based communication network ATM-KN to a receiver, the data (sub-structure elements SE and filler cells FZ together) are transmitted from the timeslot-oriented switching network module KN to the conversion unit UE, where the filler

cells FZ are removed from the TDM data stream, so that the data stream then only comprises sub-structure elements SE containing payload data. The sub-structure elements SE to be transmitted are packed in ATM cells ATM-Z1, ATM-Z2 in the conversion unit UE and are communicated via the ATM-based communication network ATM-KN to the addressed recipient. When the data are to be transmitted to, for example, an internal communication terminal device (not shown), then these are transmitted directly to a subscriber line module (not shown) via which the addressed communication terminal device is connected to the communication system PBX.

30 Figure 3 shows a schematic illustration of a conversion of the packet-oriented ATM data format according to the ATM adaption layer AAL type 2 into the timeslot-oriented data format according to the TDM method (time division multiplex) in a second operating mode of the conversion unit UE.

31 In contrast to the first operating mode of the conversion unit UE, no separate filler cells FZ are inserted into the continuous TDM data stream in the second operating mode. An adaptation of the (potentially variable) transmission bit rate of the packet-oriented data format to the constant transmission bit rate of 64 kbit/s of the timeslot-oriented data format ensues by filling the sub-structure elements SE with filler data FD, so that the overall transmission bit rate of a sub-structure element SE (payload data and filler data FD together) yields a whole multiple of 64 bit/s. This, however, assumes that each TDM channel K0 through K3 additionally has information about the length of the sub-structure elements SE that is transmitted and supplemented with filler data FD allocated to it such that a separation of the payload data to be transmitted from the filler data FD is enabled with the assistance of this information.

32 When, proceeding from the first communication terminal device KE-A, data are to be communicated to the second communication terminal device KE-B, the first communication terminal device KE-A sends the necessary signaling information to the communication system PBX in the framework of a signaling phase preceding the payload transmission, sending these information via a defined sub-structure element SE of a first ATM channel V-A, which is frequently abbreviated as VC

(virtual channel ) in the literature. The transmitted signaling information are unpacked in the conversion unit UE, converted into the HDLC data format and communicated to the control unit STE.

33 On the basis of the communicated signaling information, a TDM channel -- for example, the TDM channel 17 -- of the timeslot-oriented connecting line ZO-VL is allocated to the sub-structure elements SE of the first ATM channel V-A that are defined for the transmission of the payload data from the first communication terminal device KE-A to the communication system PBX. Furthermore, the communicated signaling information are converted into switching-oriented control data for the timeslot-oriented switching network module KN. The switching-oriented control data define which input TDM channel -- for example, the TDM channel 17 of the timeslot-oriented connecting line ZO-VL -- is connected to which output TDM channel of the timeslot-oriented switching network module KN -- for example, the TDM channel 23 of the timeslot-oriented connecting line ZO-VL.

34 Subsequently, the first communication terminal device KE-A packs payload data to be transmitted into sub-structure elements SE that are in turn packed in ATM cells ATM-Z1, ATM-Z2 and subsequently communicated via the first ATM channel V-A to the communication system PBX. The sub-structure elements SE are unpacked from the ATM cells ATM-Z1, ATM-Z2 in the conversion unit UE. In a next step, the transmission bit rate deriving due to the size and the arrival of the sub-structure elements SE is matched to the constant transmission bit rate of 64 kbit/s by inserting filler cells FZ according to the first operating mode of the conversion unit UE.

35 The data -- composed of sub-structure elements SE and filler cells FZ -- are subsequently forwarded via the TDM channel 17 of the timeslot-oriented connecting line ZO-VL to the timeslot-oriented switching network module KN. The data are switched onto the TDM channel 23 of the timeslot-oriented connecting line ZO-VL by the timeslot-oriented switching network module KN and are sent back to the conversion unit UE. The filler cells FZ are removed from the continuous data stream in the conversion unit UE, so that the data stream is not composed only of sub-structure elements SE containing payload data. These sub-structure elements SE

are subsequently packed into ATM cells ATM-Z1, ATM-Z2 and transmitted to the second communication terminal device KE-B via a second ATM channel V-B.

36 The above-described method is illustrative of the principles of the present invention. Numerous modifications and adaptations thereof will be readily apparent to those skilled in this art without departing from the spirit and scope of the present invention.

 